5-2021

Manifestations of Food Insecurity in Pediatric Populations

Kelsey S. Rowe
Philadelphia College of Osteopathic Medicine

Philadelphia College of Osteopathic Medicine
Graduate Program in Biomedical Sciences
School of Health Sciences

MANIFESTATIONS OF FOOD INSECURITY IN PEDIATRIC POPULATIONS

A Capstone in Public and Population Health Leadership by Kelsey S. Rowe

Submitted in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Biomedical Sciences, Public and Population Health Leadership Concentration

May 2021

ABSTRACT

Food insecurity is the inability to acquire food required for a healthy lifestyle. Childhood food insecurity impacts 13.6% of American children, approximately 5.3 million children are living in food insecure households. Food insecurity is a major public health concern in the United States and must be eradicated in order to develop a healthy nation. This paper focuses on the manifestations of food insecurity in pediatric populations and possible interventions. Data was collected from peer reviewed articles that were obtained using EBSCOhost and Pubmed.gov. Research found food insecurity is associated with anemia, poor school performance, behavioral health disorders, stunting, wasting, obesity, hypertension, and poor oral health in children. These manifestations create a complex paradigm involving childhood food insecurity. Thus, interventions should focus on multifactorial causes of the manifestations of food insecurity, such as nutrient consumption and diet diversity.

INTRODUCTION

Food insecurity is the consistent inability to obtain food required for a healthy lifestyle[1]. Food insecurity remains a persistent public health problem worldwide[1,2,3]. Household food insecurity is the inability to obtain enough food for the household[3]. Childhood food insecurity is when children are directly impacted, thus having a regular reduction in their food intake[3]. It is not uncommon for children to be food secure while their parents are food insecure. This is due to the parent's attempt to protect the children from food insecurity, sacrificing their own hunger for their children[3]. In 2019, 13.6% of households containing children were impacted by food insecurity. Out of this percentage, half of the children in these households were food secure, meaning the household adults suffered from the food insecurity, but the children did not[1]. Levels of food insecurity, defined as high, marginal, low, or very low, define the ranges of experience in terms of access to food. Although the rate of food insecurity has remained high since the Great Recession in 2009, rates have been declining since 2011[2]. Food insecurity reached its lowest percentage before the beginning of the COVID-19 pandemic[4]. Feeding America projects a 4.1% increase in household food insecurity levels in 2020 due to the COVID-19 pandemic[4]. This increase will be harmful to children, and families, worldwide[4]. The negative effects of food insecurity have been widely documented[1,2,3,5]. However, the paradigm of food insecurity and its manifestations have been difficult to research[1,5]. The effects of food insecurity on children may be detrimental and persist into adulthood[1,2,35].

BACKGROUND

Research on the association of food insecurity on child health and development is becoming more prominent[1,2]. Nutrition is a major influencer of human growth and development, and the manifestations of undernutrition have been described in several studies [1,2,5,6]. Undernutrition has been documented to have long lasting negative effects into adulthood; this includes physical and mental health damage to children[3,4]. The USDA demonstrates the importance of the consumption of nutrient dense foods throughout all life stages[3]. Nutrient dense foods contain macronutrients, vitamins, and minerals, with low amounts of added sugar, saturated and trans fats, and sodium. Nutrient dense foods include vegetables, fruits, beans, whole grains, nuts, seeds, and low-fat dairy products[3]. Foods that should be avoided are non-nutrient dense and are high in added sugar, sodium and saturated and trans fats. Theses unhealthy foods are commonly processed highly. High intake of unhealthy foods that are non-nutrient dense has been proven to lead to chronic disease, such as obesity, cardiovascular disease, diabetes, and cancer[3].

Inadequate nutrient intake coupled with food insecurity may manifest into disorders and diseases experienced by children. These conditions are able to persist into adulthood[3,4]. Studies have shown the negative consequences of food insecurity in children include anemia, behavioral health disorders, poor school performance, stunting and wasting, obesity, hypertension, and poor oral health[1,2,5,6]. This paper will investigate each manifestation of food insecurity and its implications on childhood health.

Anemia

Anemia is a condition of low hemoglobin concentration or low red blood cell count. Due to hemoglobin's role in oxygen transportation, individuals suffering from anemia lack sufficient blood oxygen transport for the body to perform physiological tasks[5,6] The World Health Organization defines anemia as a global public health issue that impacts 42% of children under the age of five and 40% of pregnant women, globally[7]. Anemia has been associated with increased children and women mortality and may result in poor birth outcomes, decreased productivity, and impaired cognitive or behavioral development in children[6]. Factors that can cause anemia include inadequate nutrient consumption, environment, and socio-demographic conditions. Anemia is mainly a result of iron, vitamin A, B2 (riboflavin), B6 (pyridoxine), B9 (folic acid), and/or B12 (cobalamin) insufficiencies[5,7,8]. Other factors that may lead to anemia include poverty, lack of health services, and food insecurity[5]. Anemia has also been associated with wasting, stunting, underweight, and decreased academic performance in children[5,8,9]. Investigating the prevalence of anemia in relevance to food insecurity is challenging. Multiple factors, including geographical scale, must be considered due to the varied etiology of the disease[6]. It has been shown that age and other variables in the population have significant impact on food insecurity and anemia[5]. The prevalence of studies investigating childhood anemia and food insecurity are increasing. Studies have shown strong associations between food insecurity and anemia in children[5,8]. Higher prevalence of anemia has been associated with younger children, compared to children older than 24 months[9]. The prevalence of anemia decreases with increasing age in children, studies have suggested[5,9]. Higher levels of anemia may be associated with younger children due

to their rapid growth within the first two years and/or parents of the household protecting their younger children from food insecurity[5,9]. The impact of inadequate nutrition and food insecurity on anemia is marked. It is important to focus interventions on adequate nutrient consumption and food insecurity as a whole[5,8,9].

Behavioral Health and Depression

Mental health involves the cognitive, emotional, behavioral, and social well-being of an individual[10]. Depression is a mental health disorder that negatively impacts an individual's mood, affecting one's thoughts and daily activities. There are many different forms of depression that may develop; factors leading to depression include genetics, personality, environmental factors, medications, and traumatic life events[10]. While depression only affects 3.2% of children in the United States, the prevalence of depression in children is increasing[10,11]. It has also been shown that depression commonly occurs with anxiety and other mental health problems. Of children with depression, 32.3% and 20.3% also suffer from behavioral problems or anxiety, respectively[11]. Previous studies have shown a correlation between food insecurity and negative mental health outcomes; depression is a major mental health outcome that has been associated with food insecurity[10,12]. Studies have shown that food insecurity is a predictor of social withdrawal behaviors and has been correlated with a reduced participation in school activities, disruption to social interactions, lower education expectation, lower motivation to "climb the social ladder," and lower self-efficacy[12,13,14,15]. This may be attributable to food insecurity's association with depression[12]. Food insecurity has also been linked to

stressful home environments, which is significantly connected to depression[12]. One link between food security and depression may be the social stigma children face. When a child is suffering from food insecurity, households are unable to provide food that follows social norms. As a result, children may become embarrassed and feel isolated from social interactions, which can lead to depression[12,13]. Mejis et al. (2019) focused on social exclusion related to food insecurity in terms of classroom birthday celebrations. Inability to participate in birthday celebrations through food leads to stigmatism and social exclusion among children in school. Social exclusion may manifest into long-term consequences in adulthood, such as depression[13].

Depression has been proven to increase inflammation[16]. This excess inflammation has serious immune and other health consequences. Increased inflammation increases the risk for cardiovascular disease, diabetes, rheumatoid arthritis, psoriasis, and asthma[16]. Depression and inflammation fuel one another, and thus inflammation increases the risk for depression, while depression causes increased inflammation[16]. The connection between food insecurity and depression may result in increased inflammation, which has serious negative health manifestations. The impact of food insecurity on depression is confirmed[12]. As a result, children suffer from social withdrawal behaviors, lower education expectation, and increased inflammation[12,14,15]. The effects of food insecurity on mental health will persist into adulthood, therefore it is imperative food insecurity is combated[16].

School performance

Food insecurity, along with depression, can also lead to poor school performance in children. Moreover, school performance has been proven to be a predictor of child education and development[12]. Zhang & Yang (2019) determined depression and educational expectation mediated the association between food insecurity and poor school performance in children[12]. The study showed the highest level of food insecurity was associated with poorer school performance[12]. Food insecurity in children has also been associated with higher school absenteeism, lower scores in language, reading, writing, mathematics, and science, reduction in educational expectation, decreased participation in school activities, and higher likelihood of repeating a grade[12, 17, 19]. High school students who grow up in food insecure households are more likely to get suspended or fail to graduate[19]. Research on the impact of poor school performance in children and its implications into adulthood is growing; research suggests food insecure children suffering from poor educational attainment predicts difficulty to perform in the contemporary workforce in adulthood[19].

While previous studies have hypothesized poor academic achievement in food insecure children is attributable to nutritional deficiencies, recent studies have shown no nutritional deficiencies in children in food insecure households[18]. This is most likely due to parents shielding their children from the food insecurity, thus compromising their own nutritional needs to provide adequate nutrients for their children[17,18,19]. This suggests children are still at risk for negative outcomes of food insecurity, regardless of nutritional status. Studies have shown a connection between poor school performance and food insecure children, but not in households with only parent-reported food insecurity. This

raises the importance for focus on childhood food insecurity, rather than only household food insecurity[17].

Stunting / Wasting

Stunting and wasting and are types of manifestations associated with undernutrition, as categorized by the WHO[20,21,22]. Wasting is relevant to weight and height, while stunting refers to height and age[20,23]. According to the WHO, the 2020 prevalence rate of stunting and wasting in children under the age of five years was 22.0% and 7.5%, respectively[20]. However, the incidence of stunting has been declining in recent years[20,21,24]. Stunting has been proven to negatively affect child growth and development. Stunting may be associated with diarrheal disease and environmental enteric dysfunction[24]. Wasting predisposes children to long term developmental delays, infection, and increased risk of premature death[23]. Wasting is responsible for approximately 4.7% of all deaths in children under five years age[20,23]. In previous studies, stunting and wasting has been associated with food insecurity[12, 22, 23]. The connection between stunting and wasting with nutrition is not fully understood and must be further investigated[1].

Obesity

Obesity is the condition of having excess fat accumulation that increases the risk for health issues. A body mass index of over 30 is considered obese. Obesity affects

19.3% of children in the United States overall[25]. The prevalence of obesity in children has been shown to increase with age[25]. Obesity increases the risk for metabolic syndrome, diabetes, cardiovascular disease, fatty liver disease, cancer, and premature mortality[25,26]. Obesity can manifest due to excess calorie intake and insufficient physical activity, which contribute to weight gain[25,26]. While previous research has shown associations with childhood food insecurity and obesity, other factors such as physical activity level and dietary diversity have not been fully examined[27,28]. Food insecurity may lead to obesity due to overconsumption of less expensive, non-nutrient dense foods, nonuniform food intake patterns, and lack of physical activity[25,26,27]. Previous research has suggested food insecure families are less likely to make time for physical activity, compared to food secure families. Food insecure families also showed reduced desire to makes changes their low physical activity lifestyles[28]. Children, especially younger children, have limited ability to change their healthy behaviors. Parents and caregivers, along with schools, are the primary source for enacting change in a child's lifestyle[28]. Interventions should be focused on school systems in order to promote healthy lifestyle changes to increase physical activity in children, and potentially decrease rates of obesity[25,27,28].

Hypertension

While hypertension, high blood pressure, in children is not a severe public health threat, only effecting 4% of children, the complications of high blood pressure may persist into adulthood[29]. Hypertension increases the risk for cardiovascular disease, heart failure, stroke, kidney disease, obesity, diabetes, and peripheral artery disease in adults[29].

Studies have shown food insecure children are at an increased risk for hypertension. Children living in food insecure households saw a 3% increase in odds of hypertension compared to food secure households[30]. Previous studies have shown poor nutrition early in life increases the chance of developing hypertension in late childhood or adulthood[30]. Healthy eating and physical exercise have been proven to reduce hypertension and prevent cardiovascular disease[29,30]. Mitigating food insecurity in children may decrease the rate of child and adult hypertension, along with associated diseases and disorders. More research must be done on childhood food insecurity and its impact on hypertension[30].

Oral Health

Oral health is correlated with overall health, it has been suggested to set the stage for the overall health of children and adults[31,32,33]. Poor oral health can contribute to cardiovascular disease and increased risk of infection[31]. Tooth decay, also known as dental caries, is the leading cause of childhood disease in the United States, although is largely preventable[32,33]. If left untreated, tooth decay can lead to infection, tooth pain, gum bleeding, poor school performance, overall poor oral health, and increased hospitalizations[31,32,33]. Poor oral health in childhood may manifest into cardiovascular disease, hypertension, peripheral artery disease, and obesity into adulthood[31]. Food insecurity has been strongly associated with tooth decay and poor oral health. Hill (2019) found 86% of children experiencing tooth decay were food insecure. Other studies have

shown an almost 400% increase in the likelihood of unmet oral health needs in children who are severely food insecure, compared to food secure children[33].

Fast food consumption has been proven to be increased in food insecure households; specifically, food insecure children are three times more likely to consume fast food compared to food secure households[31]. This exposes children to excess added sugar, unhealthy fat, and sodium. Fast food consumption increases the risk for hypertension, cardiovascular disease, obesity, and tooth decay[31]. The association of fast food consumption and tooth decay may be exacerbated by food insecurity. More research must be done on the connection between fast food consumption, nutritional status, and food insecurity on oral health and tooth decay in children[32].

RESEARCH STRATEGIES

Information was obtained from the search engines EBSCOhost and Pubmed.gov. Peer reviewed articles published after 2016 were examined. Search terms involved “food insecurity,” “children,” “nutrition,” “weight,” “mental health,” “diet diversity,” and “physical activity.” Reputable website sources, U.S. Department of Agriculture, World Health Organization, U.S. Department of Health and human Services, Centers for Disease Control and Prevention, and Feeding America were utilized to obtain additional information and statistics on food insecurity. Research focused on food insecurity in children from birth to adolescents, negative outcomes of food insecurity, and interventions and health outcomes.

DISCUSSION

The previously mentioned manifestations of food insecurity in children, such as anemia, social withdrawal behaviors, social exclusion, depression, poor academic achievement, stunting, wasting, obesity, hypertension, and poor oral health, have been supported by multiple current studies. Each negative health outcome has multifactorial causes that may be exacerbated by food insecurity. The complex paradigm of childhood food insecurity and health is illustrated by Figure 1. These interrelated disorders and diseases are associated with one another, proving the importance, and also the challenge, of combating food insecurity. Major indirect consequences of food insecurity include social withdrawal behaviors, depression, increased inflammation, poor school performance, poor oral health, increased risk of infection, stunting, wasting, premature death, hypertension, peripheral artery disease, diabetes, cardiovascular disease, and cancer. The major underlying factors that are potentially associated with the manifestations of food insecurity involve a lack of adequate nutrition, poor diet diversity, and lack of physical activity. Combating food insecurity through adequate nutrition, a diverse diet, and increased physical activity may prove beneficial.

While poor nutrition is not the distinct cause of the manifestations resulting from food insecurity, interventions focused around nutrient consumption may improve consequences of food insecurity in children. For example, anemia, stunting, wasting, hypertension, and poor oral health are caused, in part, by inadequate nutrition. Interventions aimed to improve nutrient consumption may provide relief to certain manifestations of food insecurity. Research has shown that nutrition facts labeling on

food reduces consumption of total calories and fat and increases consumption of vegetable[34]. Therefore, focusing interventions for food insecurity on nutrition adequacy through food labeling may be successful.

Increasing physical activity in children suffering from household food insecurity may improve obesity and hypertension outcomes. Regular physical activity has been proven to reduce the risk for diabetes, cardiovascular disease, cancer, and obesity. These are all major indirect manifestations of food insecurity. If interventions for childhood food insecurity involved the implementation of increased physical activity, manifestations of food insecurity may reduce.

While there are many manifestations indirectly and directly caused by food insecurity in children, there are also many potential solutions. Due to the paradigm displayed by food insecurity and its outcomes, there is no one answer for combating this global public health issue. More research must be done on nutritional adequacy and physical activity in order to eradicate food insecurity and its manifestations in children.

RECOMMENDATIONS FOR FUTURE STUDIES

Food insecurity and nutrition status are interconnected topics. In order to understand the magnitude of which food insecurity impacts the pediatric population, the manifestations must be further investigated. Since nutrition plays such a vital role in growth and development in children, the implications of a non-diverse diet should be investigated. Previous studies have shown a correlation between low diet diversity and household food insecurity. Research has suggested diet diversity may play a role in obesity. Therefore, future studies should focus research on the association of diet diversity and food insecurity in children. This may provide insight into possible interventions. Along with diet diversity, education of nutrition using food labels may reduce food insecurity and the manifestations associated. While current research shows food labeling may improve nutrient consumption, research must be done on the impact of labels on food insecurity, specifically. Throughout this research it will be important to differentiate between household food insecurity and childhood food insecurity. This is due to the potential for parents and caregivers to protect their children from food insecurity. Some food insecure households may have food secure children, thus influencing the outcome of manifestations.

APPENDIX

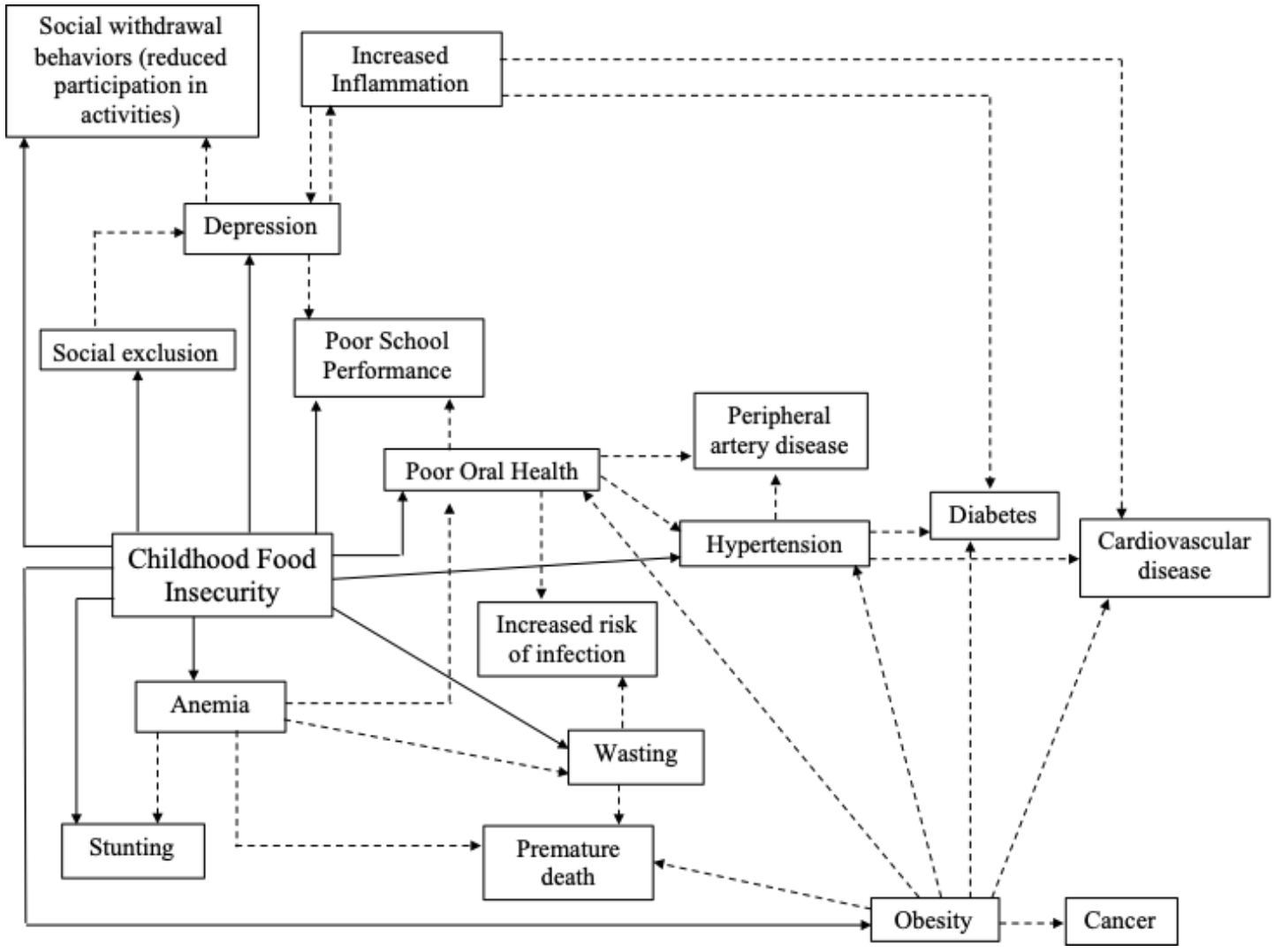

Figure 1. Conceptual model of the relationships between the manifestations of food insecurity in children. Preliminary model represents the complex interactions of diseases and disorders associated with food insecurity[6,12,13,15,2326,30,32]. Solid arrows indicate direct manifestations of food insecurity. Dashed arrows represent secondary manifestations indirectly caused by food insecurity.

REFERENCES

1. Drennen, C. R., Coleman, S. M., Cuba, S. E., Frank, D. A., Chilton, M., Cook, J. T., Black, M. M. (2019). Food Insecurity, Health, and Development in Children Under Age Four Years. *Pediatrics, 144*(4).
2. Thomas, M., Miller, D., Morrissey, T. (2019). Food Insecurity and Child Health. *Pediatrics, 144*(4).
3. *Food Insecurity in the U.S.* USDA ERS . (2021, March). https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/.
4. Hake, M., Dewey, A, Engelhard, E., Stayer, M., Dawes. S., Summerfelt, T, & Gundersen, C. (2021, March). *The Impact of Coronavirus on Food Insecurity*. Feeding America. https://www.feedingamerica.org/research/coronavirus-hunger-research.
5. Yang, Q., Yuan, T., Yang, L., Zou, J., Ji, M., Zhang, Y., Deng, J., & Lin, Q. (2019). Household Food Insecurity, Dietary Diversity, Stunting, and Anaemia among Left-Behind Children in Poor Rural Areas of China, *Int. J. Environ. Res. Public Health, 12, 4778.*
6. Palacios-Rodríguez, G., Mundo-Rosas, V., Parra-Cabrera, S., García-Guerra, A., Galindo-Gómez, C., Gómez-Humarán, I. (2019). Household food insecurity and its association with anaemia in Mexican children: National Health and Nutrition Survey 2012. *International Journal of Public Health, 64:*1215–1222
7. Chaparro, C., & Suchdev, P. (2019). Anemia epidemiology, pathophysiology, and etiology in low- and middle-income countries. *Ann N Y Acad Sci, 1450(1*): 15-31.
8. World Health Organization. (2021). *Anemia*. World Health Organization. https://www.who.int/health-topics/anaemia#tab=tab_1.
9. Engidaye, G., Melku, M., Yalew, A., Getaneh, Z., Asrie, F., & Enawgaw, B. (2019). Under nutrition, maternal anemia and household food insecurity are risk factors of anemia among preschool aged children in Menz Gera Midir district, Eastern Amhara, Ethiopia: a community based cross-sectional study. *BMC Public Health, 19*(*1*): 968.
10. U.S. Department of Health and Human Services. (2021). *Depression*. National Institute of Mental Health. https://www.nimh.nih.gov/health/topics/depression/.
11. Centers for Disease Control and Prevention. (2021, March 22). *Data and Statistics on Children's Mental Health*. Centers for Disease Control and Prevention. https://www.cdc.gov/childrensmentalhealth/data.html.
12. Zhang, L and Yang, F. (2019). Food insecurity and school performance among the left-behind children in rural China: Depression and educational expectation as mediators. *School Psychology International, 40(5):* 510-524.
13. Mejis, L., Handy, F., Simons, F., Roza, l. (2019). A Social Innovation: Addressing Relative Food Insecurity and Social Exclusion. *International Society for Third-Sector Research, 31:* 894-906.

14. Shankar, P., Chung, R., & Frank, D. (2017). Association of Food Insecurity with Children's Behavioral, Emotional, and Academic Outcomes: A Systematic Review. *JDBP, 38(2).*

15. Faught, E., Williams, P., Willows, N., Asbridge, M., & Veugelers, P. (2017). The association between food insecurity and academic achievement in Canadian school-aged children Public Health Nutrition, 20(15)

16. Kiecolt-Glaser, J., Derry, H., & Fagundes, C. (2015). Inflammation: Depression Fans the Flames and Feasts on the Heat. *Am J Psychiatry, 172:11,* 1075-1091.

17. Jamaluddine, Z., Sahyoun, N., Choufani, J., Sassine, A., & Ghattas, H. (2019). Child-Reported Food Insecurity Is Negatively Associated with Household Food Security, Socioeconomic Status, Diet Diversity, and School Performance among Children Attending UN Relief and Works Agency for Palestine Refugees Schools in Lebanon. *The Journal of Nutrition, 1;149(12):*2228-2235

18. McIntyre, L., Kwok, C., & Patten, S. (2017). The effect of child hunger on educational attainment and early childbearing outcomes in a longitudinal population sample of Canadian youth. *Paediatrics & Child Health,* 23(5): 77–84.

19. *How do you measure hunger?* Feeding America. (n.d.). https://www.feedingamerica.org/hunger-in-america/food-insecurity.

20. World Health Organization. (2020, July 13). *Nutrition and food security*. World Health Organization. https://www.who.int/foodsafety/areas_work/nutrition/en/.

21. Raiten, D. and Bremer, A. (2020). Exploring the Nutritional Ecology of Stunting: New Approaches to an Old Problem. *Nutrients, 12(2):* 371.

22. Pathak, J., Mahanta, T., Arora, P., Kalita, D., & Kaur, G. (2020). Malnutrition and Household Food Insecurity in Children Attending Anganwadi Centres in a District of North East India. *Indian J Community Med, 45(4)*: 405-409.

23. Nepali, S., Simkhada, P., & Davies, I. (2020). Association between wasting and food insecurity among children under five years: findings from Nepal demographic health survey 2016. *BMC Public Health, 20:1027.*

24. Yang, Q., Yuan, T., Yang, L., Zou, J., Ji, M., Zhang, Y., Deng, J., & Lin, Q. (2019). Household Food Insecurity, Dietary Diversity, Stunting, and Anaemia among Left-Behind Children in Poor Rural Areas of China, *Int. J. Environ. Res. Public Health, 12, 4778.*

25. Centers for Disease Control and Prevention. (2021, April 5). *Childhood Obesity Facts*. Centers for Disease Control and Prevention. https://www.cdc.gov/obesity/data/childhood.html.

26. Papas, M., Trabulsi, J., Dahl, A., & Dominick, G. (2016) Food Insecurity Increases the Odds of Obesity Among Young Hispanic Children. *J Immigrant Minority Health 18:*1046–1052

27. Kaur, J., Lamb, M., & Ogden, C. (2015). The Association between Food Insecurity and Obesity in Children—The National Health and Nutrition Examination Survey. Journal Of The Academy Of Nutrition And Dietetics, 115(5), 751-758.

28. Gunter, K., Jackson, J., Tomayko, E., & John, D. (2017). Food insecurity and physical activity insecurity among rural Oregon families, *Preventive Medicine Reports 8*, 38–41

29. *Health Threats From High Blood Pressure*. www.heart.org. (n.d.). https://www.heart.org/en/health-topics/high-blood-pressure/health-threats-from-high-blood-pressure.

30. South, A., Palakshappa, D., & Brown, C. (2019). Relationship between food insecurity and high blood pressure in a national sample of children and adolescents. *Pediatric Nephrology, 34:*1583–1590

31. Chi, D., Dinh, M., da Fonseca, M., Scott, J. & Carle, A. (2015). Dietary Research to Reduce Children's Oral Health Disparities: An Exploratory Cross-Sectional Analysis of Socioeconomic Status, Food Insecurity, and Fast-Food Consumption. *Journal Of The Academy Of Nutrition And Dietetics, 115(10):* 1599-1604.

32. Hill, B. (2019). Evaluating the association between food insecurity and dental caries in US children 1-19 years: results from the National Health and Nutrition Examination Survey (NHANES) 2013-2014. *J Public Health Dent 80:* 14–17

33. Jackson, D. & Testa, A. (2020). Household food insecurity and children's oral health: Findings from the 2016–2018 National Survey of Children's Health. *J Public Health Dent.*

34. Shangguan, S., Afshin, A., Shulkin, M., Ma, W., Marsden, D., Smith, J., Saheb-Kashaf, M., Shi, P., Micha, R., Imamura, F., & Mozaffarian, D. (2019). A Meta-analysis of Food Labeling Effects on Consumer Diet Behaviors and Industry Practices. *Am J Prev Med. 56(2):* 300–314